GODDARD'S NEW APPROACH TO INFORMATION TECHNOLOGY

The Information Systems Center
An Overview

The 23rd Annual Software Engineering Workshop

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By Howard E. Kea

BACKGROUND

The Goddard Space Flight Center (GSFC) Strategic Implementation Plan (SIP) was published in January 1997. Since the plan was published several centerwide activities have been initiated. One in particular known as "Project Goddard" is responsible for one of the most significant changes that have occurred in Goddard's history. This was the reorganization of Codes 500 and 700. The reorganization [Reference 1] was the result of much planning that began with an assessment of the external environment and the writing of Goddard's SIP followed by definition of macro level processes from which an organization that could support those processes was derived. In today's environment, performance, cost and schedule are three critical elements to the successful execution of a program. The requirements have become an integral factor throughout the development process making it necessary for close customer involvement. The reorganization was primarily structured to more effectively focus engineering talent into teams drawn from the different disciplines. This would facilitate being able to provide products and services which support mission needs aligned with customer requirements.

INFORMATION SYSTEMS CENTER

The ISC was created as part of the Goddard reorganization and was located within the Applied Engineering and Technology (AET) Directorate. Why create an ISC? The creation of ISC was to (1) focus expertise and leadership in information system development. (2)Promote organizational collaboration, partnerships, and resource sharing. (3)Stimulate design /development of seamless end-to-end flight and ground systems. (4) Enable flexibility to effectively support many simultaneous projects by improved access to critical mass of discipline expertise. (5)Enhance career growth and opportunities including multi-disciplinary opportunities and (6) to improve communications among information system professionals. Figure 1. Is an Organizational Chart of Goddard after the reorganization showing AETD and STAAC as new organizations.

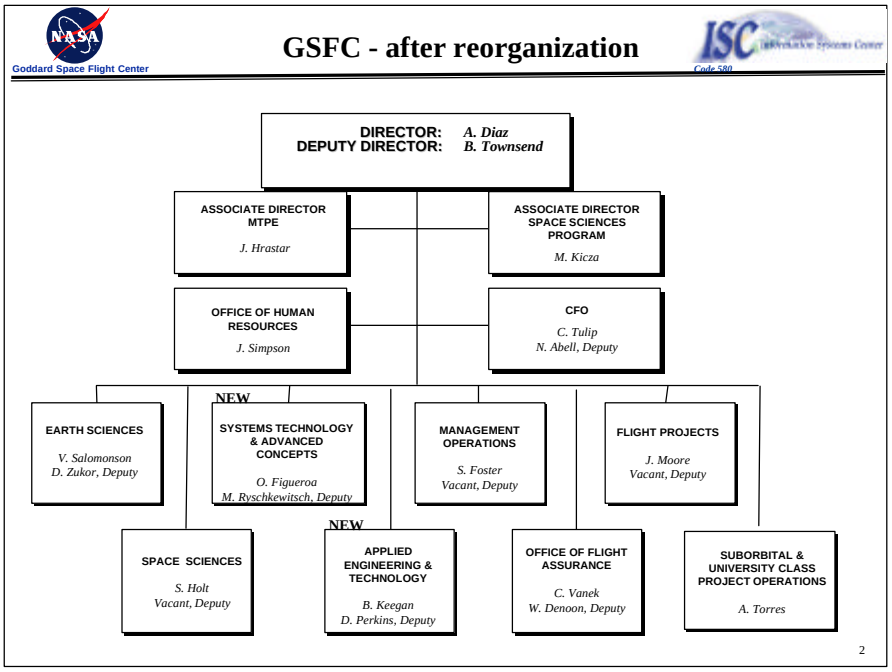


Figure 1.

Figure 2. Shows the AETD Organization, the Director is Brian Keegan.

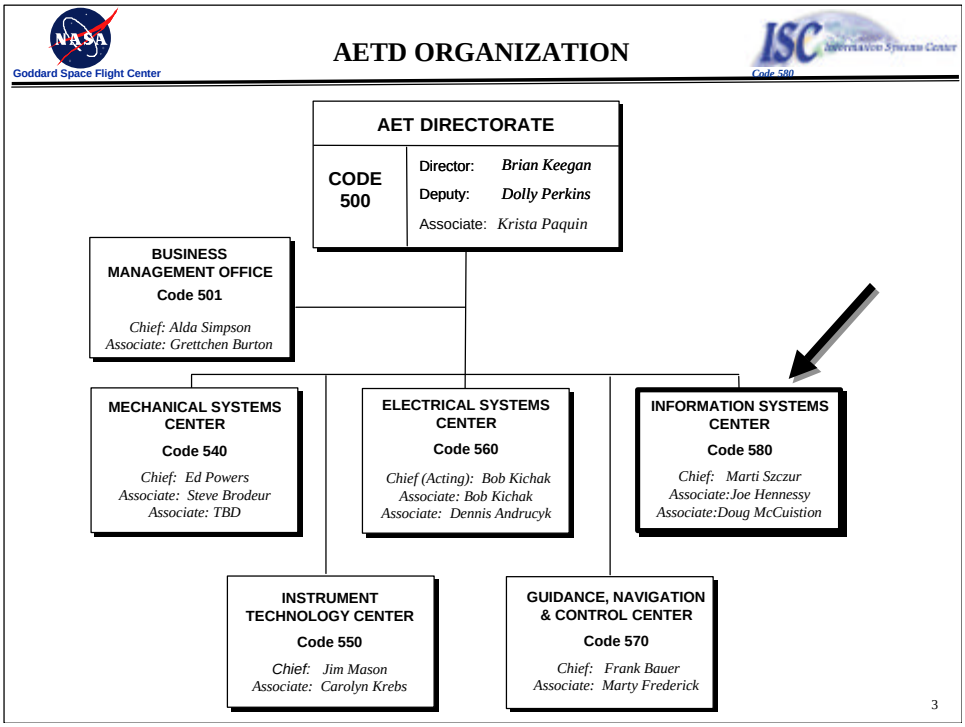
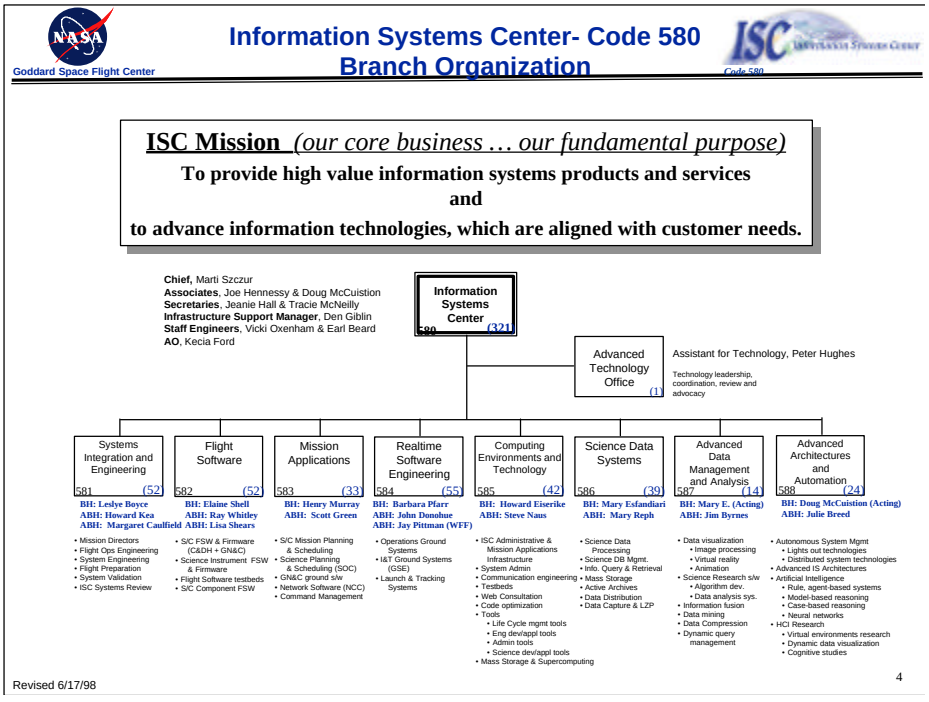


Figure 2.

There are five Engineering Centers within the AETD which are equivalent to Division level organizations. Each of these engineering centers is focused on a particular engineering discipline. The ISC (Code 580) is the engineering center focused on Software Engineering and Computer Science. The ISC Mission is [Reference 2] "to provide high value information systems products and services and to advance information technologies, which are aligned with customer needs." The ISC organization is shown in Figure 3 below.



The center has 8 branches in which each branch is focused on critical software engineering domains that cover the full lifecycle phase of a mission. Table 1. Represents each of the Branches in the ISC and highlights their major functional areas, products and services, customers and projects supported. A more detailed breakdown can be found in Attachment A. ISC is predominantly a matrix organization in that many of the Branch personnel 581, 584, 586 are co-located with the project offices. The process in which personnel are assigned is accomplished annually when the projects submit Statements of Work (SOW) to the ISC for services. Personnel with the necessary skills and experience are then assigned to the project from 1 to several years dependent on the duration of the project.

580 / Information Systems Center Branch Structure

Branch	Functional Area/Products	Services	Customer Projects/Org
581 / Systems Integration and Engineering *Leslye Boyce, Howard Kea, Margaret Caulfield*	End-to-end data systems engineering of ISC mission systems development activities.	Mission directors, ground sys/flight ops management, sys. eng., flight prep support, SW eng, Sys I&T, AO prep	EOSDIS, HST, STAAC, NGST, MAP, IMAGE, TRACE, POES, AGS, on-orbit missions
582 / Flight Software *Elaine Shell, Ray Whitley, Lisa Shears*	Embedded spacecraft, instrument and hardware component softwares; FSW testbeds	End-to-end FSW development; simulation s/w; spacecraft sustaining engineering	HST, MAP, TRMM, EO-1, SMEX, SMEX-lite, SPARTAN, EOS AM/PM/Chem, GLAS, XRS XDS, POES, NGST, XTE, EUVE, GRO
583 / Mission Applications *Henry Murray, Scott Green*	Off-line mission data systems (e.g., Command man., s/c mission and science P&S, GN&C, NCC	Sys. eng.& implementation, COTs application, testbeds for concept proof/prototyping in ops environment	NCC SPSR, LS7, EO-1, EOS AM1, HST, TRACE, C930, IMAGE SOC
584 / Realtime Software Engineering *Barb Pfarr, Jay Pittman, John Donohue*	Real-time ground mission data systems for I&T and on-orbit ops (e.g., s/c command & control, launch and tracking services)	Sys. eng.& implementation, COTs application, simulators, testbeds for concept proof/prototyping in ops env.	HST, WFF, ISTP, IMAGE, MAP, SMEX, TRACE,WIRE, EO-1, LS7, HITCHHIKER, SPARTAN, EOS, NGST
585 / Computing Environments and Technology *Howard Eiserike, Steve Naus*	Tools and services in support of information management	Hands-on sys admin., network manage., business/support tool develop, WWW application	EOSDIS, IFMP, C630, C930, HST, WSC, C250, C450, HST
586 / Science Data Systems *Mary Ann Esfandiari, Mary Reph*	Science data systems including data processing, archival, distribution, analysis & info man.	Sys. eng.& implementation, COTs application & integration, testbeds, prototyping	EOSDIS, LS7, TRACE, TRMM, HST
587 / Advanced Data Management and Analysis *M. Esfandiari (Acting), Jim Byrnes*	Advanced concept development for archival, retrieval, display, dissemination of science data	Next-gen req. development, testbed for sys evaluation, prototype products	FAST, NEAR, WIND, ULYSSES, C632, C686, C694, C930, C922
588,/Advanced Architectures & Autonomy *Doug McCuistion (Acting), Julie Breed*	Technology R&D focused on space-ground automation sys. and advanced architectures	Sys. eng & implementation, human-computer eng., technology evaluations, concept prototypes, sw eng. methods	NCC, STAAC, SOMO, Code SM, EOSDIS, MIDEX, NGST

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Table 1.

In March 1998 the ISC held is first Management Team Retreat to develop a Vision, Mission and Strategic Goals. The Vision of ISC is to be a world-class information systems center of excellence serving the needs of GFSC and NASA customers.

- ISC has a diverse, talented innovative, energized, internationally recognized, workforce of employees and managers.
- ISC is the employer of choice providing a flexible, learning work environment; fair and credible promotions, training, development, and awards; and premier development tools and facilities.
- ISC is the leader and focal point for cutting-edge information technology for Goddard's customers in Earth and Space Science and for advanced information technologies to support institutional customers.
- ISC delivers innovative, customer-oriented solutions, products and services.
- ISC's relationships with customers are open, flexible, collaborative and based on trust and mutual respect.
- ISC operates like a business with responsive, efficient, value-added processes, enabling technology infusion/transfer and effective delivery of products and services.
- ISC has an extensive network of information technology partners and alliances to expand knowledge, leverage resources, and provide delivery of customer-oriented solutions.

The ISC has 4 simple but very critical Strategic Goals to achieve in the next 5 years they are to:

1. Advance leading-edge information systems technology.
2. Clearly define the scope of ISC business, and deliver high value products and services that satisfy customer needs.
3. Build a diverse, talented, innovative, energized, internationally recognized, workforce of employees and managers.
4. Establish open, flexible, collaborative relationships with customers and partners.

These strategic goals are aligned with the Goddard Strategic Goals.

Role of the Software Engineering Laboratory in ISC

Given the external drivers such as "Agenda for Change " which promulgated the creation of the ISC, the SEL has an opportunity to leverage its capabilities to help the ISC meet its strategic goals and objectives. There are several areas where the SEL can be an enabler for software process improvement:[Reference 3]:

- Build an improvement organization within the ISC that will increase the competency of its software engineering professionals, thereby increasing the quality of Goddard software systems.
- Model and characterize software systems in use on the ground and onboard spacecraft.
- Transfer and help tailor proven development and maintenance technologies to new domains, internal and external to GSFC.

As a result of Goddard's organizational changes, a new vision and mission statement and new goals and objectives have been established for the SEL. Over the past several months a series of workshops had been conducted with the SEL Director's to outline and define the new direction for the SEL and still maintain its heritage over the past 20 plus years. The SEL's new Vision and Mission statement is:

Software Engineering Laboratory Vision:

To be internationally recognized as a leader for applied research in Evolutionary Software Engineering Process Improvement.

Software Engineering Laboratory Mission:

"Serve as a World Class Laboratory dedicated to evolutionary software engineering process improvement and serve as a clearinghouse within GSFC for software engineering best practices. And to foster the development of highly skilled software engineers in the ISC and in GSFC and contractor community through continued education and training of software development practices and methodologies."

Mission Objectives:

1) To study, research and roll out products from our best practices and methodologies.
2) To provide useable and applicable products aligned with customer needs.
3) To increase visibility, size and scope.
4) To partner with other software engineering organizations.
5) To serve as clearinghouse within ISC/GSFC for Software Engineering process improvement information.
6) To educate the software engineering community on software engineering best practices.
7) To identify resources for funds.
8) To develop quickie products e.g. "reusable abstractions" and modularize SEL documents into a handbook format.
9) To develop strategies for rolling out practices to customers and immersing customers in the process.

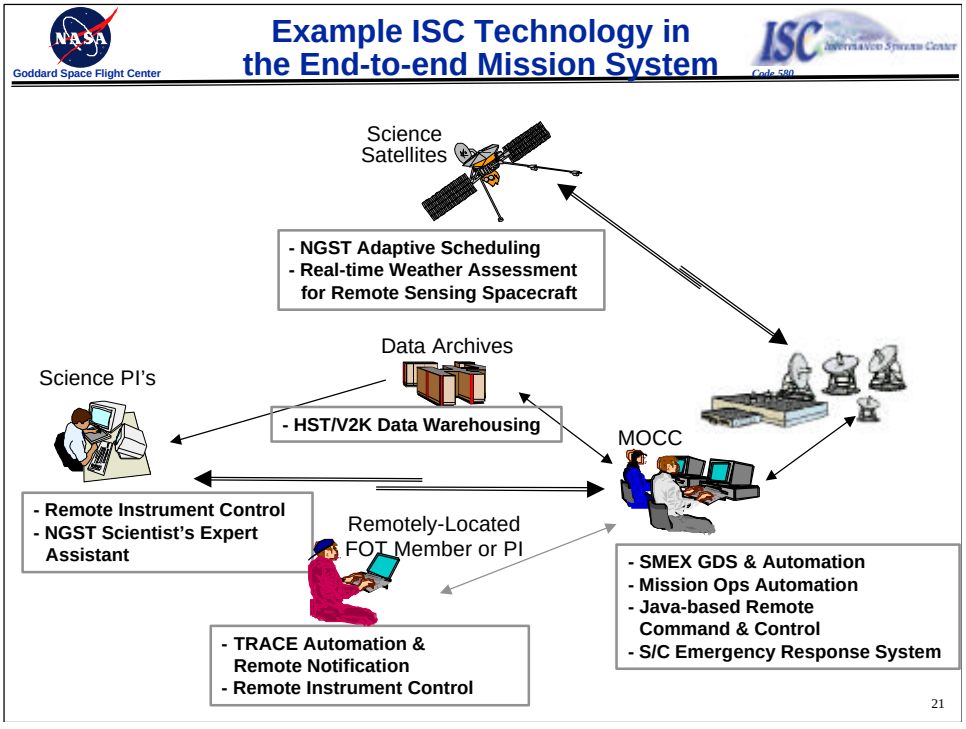
The current base of SEL activities include: management of databases and producing monthly reports, development of WEB based forms to eliminate file transfer, maintenance of SEL Library and development of Software Engineering Courses. Current research topics include Meta-process, Baseline Process and Core Metrics development. Short term and long term goals for the SEL have been established. They are:

SEL Shorterm Goals:

1) Software Engineering Workshop
2) Complete ISC Baseline
3) Update Webpage
4) Develop customer focus teams
5) Increase GSFC Visibility and Interaction

SEL Long-term Goals:
1) Develop a full Software Engineering Training Development Program
2) Assist the ISC in obtaining CMM level 2 & 3
3) Establish Partnerships with other Software Engineering Process Improvement organizations

Under the new SEL structure, the ISC Branches and Teams would work more closely with the SEL in defining current processes and developing improved processes (Figure 4). The SEL Analysts role would expand to encompass end-to-end systems development processes, form requirements definition through maintenance and operations. In addition, new metrics will be developed that include the complete lifecycle of the end-to-end systems development process. An example of the end-to-end mission system is shown in Figure 5.



As a result of the expanded responsibilities, the SEL has already begun to Baseline the ISC branch's products and services and Software Development Processes and Team products. This effort will establish a basis for measuring the impact of software process improvement measures that are implemented within the ISC. SEL is also in the process of developing a series of lectures and courses that focus on the Software

Engineering Process incorporating the CMM philosophy. The SEL will also play a key role in helping the ISC to achieve CMM levels 2 & 3 and the presence of the SEL in ISC also provides the potential to ultimately achieve CMM levels 4 &5.

References:

(1) Keegan, B. "Applied Engineering & Technology Directorate (AETD) 500," AETD Newsletter, NASA Goddard Space Flight Center, August 1998.
(2) ISC Management Team, "ISC Retreat Report", St. Michaels, MD, March 1998.
(3) Pajerski, R. and V. Basili, "The SEL Adapts to Meet Changing Times," Proceedings of the 22nd Annual Software Engineering Workshop, Greenbelt, MD, December 1997.
(4) Szczur, M., "Information Systems Center (ISC) Overview Briefing", NASA Goddard Space Flight Center, May 1998.
(5) Kea, H., "Software Engineering Laboratory Overview," NASA Goddard Space Flight Center, September 1998.

ATTACHMENT A.

Code 581

The System Integration and Engineering Branch provides expert advise and technical consultation to Principle Investigators and Mission Study Managers on operational concepts, data systems architectures and life-cycle costing. It provides end-to-end engineering of ISC mission systems development activities, including software development and flight operations. It provides expert consultation on software process improvements, technology assessments and product evaluation.

Core Capabilities

- Operational Concepts and Architecture Definition
- Technology Assessment and Analysis
- Software Engineering Consultation and Process Improvement
- Data System Development and Management
- Requirement Analysis and Tracking
- Flight Operations Engineering
- Implementation Engineering
- Technical Management of Contracts (i.e., SOMO)
- Assist MSM-SOMO
- Mission and Timeline Planning

Additional Areas of Expertise

- Ground System Implementation Management
- Shuttle Operations and Data Management

Products

- Integration Test & Test Operations System (ITOS)
- Advanced System for Integration & Spacecraft Test
- Explorer Front-end Data System (EFEDS)

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Major Customers

- Principal Investigators
- STAAC Mission Study Managers
- Science Teams
- Project Managers

Key Accomplishments

- EO-1 EFEDS
- HST CCS Development
- SMEX ITOS Development
- ESDIS FOS
- MAP ASSIST Development

- Alternative Architecture Assessment

Code 582

The Flight Software Branch is responsible for developing Embedded S/W products for on-board data handling; management and control of Flight H/W

Core Capabilities

- Spacecraft Flight software
- Science Instrument Flight Software
- Attached Payload Software
- Flight Component Software
- Flight Software Simulators and High Fidelity Dynamics Testbeds
- Technology Assessments and Prototypes
- Flight and Ground Trades
- Flight Hardware Diagnostics
- Smart Spacecraft and Science Instruments
- Flight Software Engineering
- Hardware and Flight Software Integration Testing
- Flight Software Integration Verification and Validation
- Flight /software Sustaining Engineering

Additional Areas of Expertise

- Flight Software Tools

Code 583

The Mission Applications Branch Provides system engineering of off-line systems and applications to meet Earth and Space Science mission objectives. The branch provides conceptualization, requirement analysis, design, implementation and mission-life sustaining engineering of products. Branch mission supports include ground support systems for attitude and orbit determination, spacecraft command memory management, mission and science operations planning and scheduling, and trend analysis. Branch personnel apply cutting edge technologies and integration of COTS products to provide cost-effective data systems which meet customers' needs. The branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners to advance the state-of-the-art in our systems and related technologies. Additionally, the branch develops Testbeds and models to verify concepts in an operational environment.

Core Capabilities

- Command Memory Management Systems
- Science Instrument Support Systems

- Mission and Science Operation Planning and Scheduling Systems
- Mission Planning Aids
- System and Software Engineering
- COTS software Evaluation and Integration
- Technology Assessment , Development and Infusion

Additional Areas of Expertise

- Attitude and Orbit Determination Systems
- Trend Analysis Systems
- Trajectory Determination Systems
- Sustaining Engineering
- NCC Data Systems

Major Customers

- SMEX Project
- HST Project
- NGST Project
- EOS AM-1 Project
- EO-1 Project
- LANDSAT-7
- Scientific Visualization Studio
- Network Control Center

Key Accomplishments

- Developed TRACE Flight Dynamic Support System
- Provided TRACE Flight operations Team support for command management
- Supported animation development for Smithsonian's Earth Today exhibit
- Completed Java-based Real-time Attitude Determination technology project

Code 584

The Real-time Software Engineering Branch is responsible for Real-time ground mission data syst4ems for Integration and Testing and on-orbit operations, e.g. spacecraft command & control, launch and tracking services.

Core Capabilities

- Mission Command & Control Systems
- Science Command & Control Systems
- Engineering Data Trend & Analysis Systems
- Engineering Data Warehouse Systems
- Engineering Data Simulators
- Special Device Interface Units
- Loading Studies
- Smart Spacecraft and Science Instruments

- Spacecraft I&T Support
- Planning for Future Missions
- Software Engineering
- Flight Operations Team
- Launch Support /Scheduling/Wind Weighing
- Lead Implementation Engineering
- Technology Assessment and Analysis
- Project Management

Additional Areas of Expertise

- Information Visualization
- Numerical Analysis
- Flight Operations
- System Development
- System Engineering

Major Customers

- WIRE Project
- TRACE Project
- SMEX Project
- Hitchhiker
- ESDIS Project
- EO-1 Project
- SPARTAN Project
- MAP Project
- NGST Project
- Long Duration Balloon Program
- ACE Project
- HAST Project

Code 585

They never completed the action. This is all I have

Core Capabilities

- Code Optimization
- Supercomputing Applications and Systems
- Mass Storage Systems
- COTS Assessments, Analysis, and Inventory
- Administration Tools
- Science Development Environment Tools
- Engineering Development Environment Tools
- System Engineering

- Communications and Network Engineering
- GSFC CIO and Information Technology Management Coordination
- Technology Assessment and Analysis

Additional Areas of Expertise

- Infrastructure Applications
- Development Life Cycle Management Tools
- Sustaining Engineering
- System Administration
- Testbeds

Code 586

The Science Data Systems Branch supports the Earth and Space communities by providing science data system development, consultation, and related technology assessment. The Branch develops systems for operational data capture, level-0 and higher level data processing, data archival, data product development, data distribution, and information management. The Branch utilizes new technologies, COTS / GOTS products, cost-saving strategies, and current design and development methodologies to provide studies, consulting, prototyping, design, development, verification, and mission-life sustaining engineering for its projects.

Core Capabilities

- Science Data Processing Systems (Level 1 and Higher)
- Science Database Systems
- Science Data Product Generation Systems
- Science Data Mass Storage System / Data Warehousing / Archive Systems
- CCSDS Standards consultation
- Technology Assessment and Planned Infusion
- Science Data System Consultation
- Smart Science Instruments Support
- Customer Survey and Analysis
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Additional Area of Expertise

- Science Data Capture Systems and Level Zero Systems
- Science Data Distribution Systems
- Flight Operations Team Support

Major Customers

- ESDIS Project
- HST Project
- Landsat-7 Project
- TRMM Project
- IMAGE Project
- SMEX Project
- WIRE Project

- NSSDC

Key Accomplishments

- Significant support in the development of ESDIS

- Delivery of L-7 Product Generation System (LPGS), Image ?Assessment System (IAS), L-7 Processing System (LPS) and the Distributed Active Archive Center (DAAC) Emergency System (DES)

Code 587

The Advanced Data Management and Analysis Branch provides science data systems development, consultation and advanced information technology support in the areas of algorithm development, data display and visualization, data mining, retrieval, fusion, and dissemination, science data analysis programming, data archiving and mass storage. The current design and development methodologies to provide systems engineering, system planning and consultation, requirements development and analysis, trade-off studies, consulting, prototyping, design, development, verification and mission-life sustaining engineering for its products.

Core Capabilities

- Science Data Visualization Systems
- Science Data Analysis Systems
- Science Data Management, Mining, and Fusion and Data Compression Systems
- Smart Science Instruments support
- Technology Assessment and Analysis
- Algorithm Development
- Science Data Analysis Programming Support

Additional Areas of Expertise

- UNIX System Management
- Parallel Programming and Code Optimization

Major Customers

- Lab for Astronomy & Solar Physics
- Lab for Extraterrestrial Physics
- ISTP / WIND Project
- Space Science Data Operations Office
- Earth Space Data Computing Division

- GLOBE
- NEAR
- ULYSES

Key Accomplishments

- Key support for NEAR Gamma Ray burst timing study
- Completion of Y2K test for WIND / MFI data processing systems
- Key support to development of FPGAs for on-board data analysis utilizing UAV test platforms

Code 588

The Advanced Architectures and Autonomy Branch is responsible for technology Research and Development focused on space-ground systems automation and advanced architecture development.

Core Capabilities

- Technology Program Coordinator
- Technology Assessment Awareness
- Software Consultation and Process Improvement
- Information System Automation and Autonomy
- Advanced Information Systems Architectures
- Spacecraft and Science Instrument Modeling Tools
- Science and Mission Proposal and Design Tools
- Smart Spacecraft and Science instruments

Additional Areas of Expertise

- Engineering Data Trend and Analysis Technology
- Network Control Systems
- Control Center HCI Technologies
- Support Tools
- Sustaining Engineering